3. ESSENTIAL FISH HABITAT

Section 303(a)(7) of the Magnuson-Stevens Act, 16 U.S.C. §§ 1801 *et seq*., as amended by the Sustainable Fisheries Act in 1996, requires that Fishery Management Plans (FMPs) describe and identify essential fish habitat (EFH) within the U.S. Exclusive Economic Zone (EEZ) for all life stages of each species in a fishery management unit. Available information should be interpreted with a risk-averse approach to ensure that adequate areas are protected as EFH for the managed species. The HMS FMP addresses EFH for species managed under that plan in Chapter 6; the Billfish Amendment provides a description of EFH and related issues in Chapter 4. The EFH regulations also specify that new EFH funding information should be reviewed as it becomes available, and reported as part of the SAFE report. The FMP EFH provisions should be revised or amended, as warranted, based on the available information.

3.1 Atlantic Sharks

3.1.1 Cooperative Atlantic States Shark Pupping and Nursery (COASTSPAN) Survey

*The material presented below is excerpted from the following reports: McCandless, C. and H. L. Pratt. 2000. *1998-1999 Summary Report of the Cooperative Atlantic States Shark Pupping and Nursery (COASTSPAN) Survey*. Apex Predators Program. US DOC, NOAA, NMFS, NEFSC, Narragansett Laboratory, Narragansett, RI.; Pratt, H. L. and J. C, Carrier. 2000. *COASTSPAN Nurse Shark Mating and Nursery Grounds Project*. *Draft Report of the 1999 Apex Predators Program / Albion College*. Apex Predators Program. US DOC, NOAA, NMFS, NEFSC, Narragansett Laboratory, Narragansett, RI, Department of Biology, Albion College, Albion, MI.

Introduction

Sharks are especially vulnerable to overfishing because they grow slowly, mature late and have few young. These reproductive characteristics contribute to a long stock rebuilding time. Cooperation between federal and state governments in developing coordinated conservation measures is important to successful domestic management of coastal shark species because range, migrations and mating and pupping areas overlap some state and even federal jurisdictions. Many coastal species utilize bays and estuaries within state waters as nursery habitat (where parturition and young-of-the-year sharks occur) and/or secondary nursery habitat (utilized by juveniles, age 1+ only). Studies suggest that these inshore nursery grounds offer selective advantages of low predation rates and high forage abundance to juvenile sharks.

Little is known about the extent and ecology of shark nursery habitat along the East Coast of the United States. The HMS FMP identifies several research and information needs concerning essential fish habitat (EFH) of shark species, focusing on shark nurseries. Shark nursery areas are frequently located in highly productive coastal or estuarine waters within state boundaries. Specifically, further delineation of summer and winter nursery areas is needed to determine if

sharks return to their natal nurseries, determine habitat relationships such as temperature and salinity, determine significance of areas of aggregation, and determine the role of coastal/inshore habitats in supporting neonate and juvenile sharks. Such information is vital to understanding and managing sharks at this vulnerable stage where many sharks come closest to man's influence.

In 1998, the NMFS Apex Predators Program (APP) formed the Cooperative Atlantic States Shark Pupping and Nursery (COASTSPAN) Survey. This is an alliance of NMFS and state cooperators conducting ongoing investigations of shark nursery grounds along the East Coast of the United States. State cooperators include the following: the North Carolina Division of Marine Fisheries, South Carolina Department of Natural Resources, Savanna State University with cooperation from the Georgia Department of Natural Resources, and Florida Department of Environmental Protection (DEP). NMFS APP staff conducts the COASTSPAN study in Delaware Bay. COASTSPAN is funded by NMFS NEFSC and NMFS Highly Migratory Species Management Division.

Results presented here are a summary of the first two years of this five-year study. In subsequent years the program will continue the delineation of shark nursery areas, develop relative indices of abundance of neonate and juvenile sharks in these nursery areas, use the environmental data and bycatch collected to determine habitat relationships, and use tag and recapture data to determine if sharks return to their natal nurseries and define the overwintering nursery grounds.

Summary of Preliminary 1998-1999 COASTSPAN Findings

COASTSPAN cooperators sampled a total of 2,488 sharks in 1998 and 1999. Twelve hundred and eighty-three (52%) of the sharks sampled were tagged with fin tags and released. Florida DEP also contributed their sampling data from the Indian River Lagoon from April 1991 to March 1997. Juvenile sharks caught by the cooperators included the following: Atlantic sharpnose (*Rhizoprionodon terraenovae*), blacknose (*Carcharinus acronotus*), blacktip (*C. limbatus*), bonnethead (*Sphyrna tiburo*), bull (*C. leucas*), dusky (*C. obscurus*), finetooth (*C. isodon*), sandbar (*C. plumbeus*), sand tiger (*Odontaspis taurus*), scalloped hammerhead (*S. lewini*), smooth hammerhead (*S. zygaena*), tiger (*Galeocerdo cuvieri*), and spinner sharks (*C. brevipinna*).

Atlantic sharpnose sharks were the predominant species caught in North Carolina, South Carolina, and Georgia waters. Juvenile sharpnose sharks (including neonates) were caught in coastal waters in North Carolina, South Carolina, and Georgia and also offshore in South Carolina. Preliminary COASTSPAN findings provide supporting evidence that sharpnose sharks utilize coastal waters in these states as pupping and nursery grounds based on umbilical scar condition and size of sharks captured.

Juvenile blacknose sharks (including neonates) were caught in North and South Carolina waters. Preliminary COASTSPAN findings provide supporting evidence that blacknose sharks

use North Carolina waters off Cape Lookout as at least a secondary nursery ground. Blacknose sharks also appear to use waters offshore of South Carolina (south east of Charleston Harbor) as pupping and nursery grounds based on umbilical scar condition and size of sharks sampled.

COASTSPAN data indicate that North and South Carolina waters also support nursery habitat for juvenile blacktip sharks. Juvenile and neonate blacktip sharks were caught off Cape Hatteras and Core Sound in North Carolina, providing evidence that these areas may be utilized as pupping and nursery grounds. In South Carolina juvenile and neonate blacktip sharks were caught in St. Helena Sound, indicating these waters as possible pupping and nursery grounds for this species.

Juvenile bonnethead sharks were captured in South Carolina and Georgia coastal waters. The presence of juveniles (age 1+) in Bulls Bay and St. Helena Sound, SC lend supporting evidence that these waters contain secondary nursery grounds for bonnethead sharks. Georgia waters in St. Andrews, Cumberland, and Wassaw Sounds may support pupping and nursery grounds for bonnethead sharks based on the presence of neonate and juvenile sharks in these areas.

One juvenile bull shark was caught in St. Helena Sound, SC in 1999, and several were captured in Indian River Lagoon, FL from 1991-1997. The presence of juvenile sharks (age 1+) in these areas supports the preliminary COASTSPAN finding that these areas provide secondary nursery habitat for bull sharks.

Two juvenile dusky sharks were caught during the 1998-1999 COASTSPAN sampling seasons. One neonate was captured in coastal waters off Saltier Path, NC and one age 1+ juvenile was captured in offshore waters southeast of Charleston Harbor, SC. These preliminary findings suggest that North and South Carolina contain nursery habitat for dusky sharks based on umbilical scar condition and size of the sharks.

Juvenile finetooth sharks were found in coastal waters in North Carolina, South Carolina, and Georgia. Only age 1+ juveniles were found in North Carolina and Georgia waters, indicating that secondary nursery habitats may be located in these areas. Preliminary COASTSPAN findings show that finetooth utilize South Carolina waters to some degree as pupping and nursery grounds based on the presence of neonates and juveniles. One juvenile nurse shark was captured offshore in South Carolina waters.

COASTSPAN results show the importance of Delaware Bay as a pupping and nursery ground for sandbar sharks. Tag/recapture data and the presence of juvenile sandbar sharks during early spring, late fall, and the winter months in North and South Carolina waters gives supporting evidence that sandbar sharks use these waters as important overwintering nursery grounds. The presence of juveniles in low numbers during the summer months in South Carolina waters suggests that sandbar sharks may utilize these waters as secondary nursery habitat.

The presence of juvenile sand tiger sharks indicates that Delaware Bay may be a secondary nursery ground for this species. There were no juvenile sandtigers caught in North Carolina, South Carolina and Georgia waters during the COASTSPAN survey in 1998 and 1999.

Juvenile scalloped hammerhead sharks (including neonates) were found in the coastal waters of North Carolina, South Carolina, and Georgia. The presence of neonate and juvenile scalloped hammerhead sharks in South Carolina suggests the use of these waters as pupping and nursery grounds by this species. In North Carolina and Georgia, only one juvenile scalloped hammerhead was caught in each state, indicating that this species may utilize these waters to some degree as a secondary nursery ground.

One juvenile smooth hammerhead was caught in North Carolina in 1998. This COASTSPAN result suggests that smooth hammerhead sharks may utilize coastal waters in North Carolina to some degree as secondary nursery habitat.

Juvenile spinner sharks were found in the coastal waters of North and South Carolina. Preliminary COASTSPAN findings based on the presence of fresh umbilical scars suggest that spinner sharks utilize these waters as pupping and nursery grounds.

Juvenile tiger sharks were captured offshore in South Carolina waters. One tiger shark had a faint umbilical scar. This finding and other observations indicate that tiger sharks may utilize South Carolina's offshore waters as at least secondary nursery habitat.

Preliminary COASTSPAN findings are based on data collected by the COASTSPAN survey and data contributed by cooperating agencies. More cooperative work is needed to confirm all of these preliminary results.

COASTSPAN Nurse Shark Mating and Nursery Grounds Project

Studies of the nurse shark *Ginglymostoma cirratum* in the Dry Tortugas, FL are a critical key to understanding the reproductive dynamics of sharks. This is an ideal natural laboratory where all stages of the shark reproductive process, mating, gestation, pupping and nursery grounds are in evidence and may be observed. Studies of sharks in this remote, protected archipelago, provide a rare window on processes that are essential to the perpetuation of all shark populations. Results of this research can serve as a template for the management of shark EFH. Since 1991, NMFS and several other institutions have been engaged in ongoing cooperative studies on nurse shark reproduction, mating and nursery grounds. Work conducted in FY 2000 was largely a cooperative effort between NMFS APP and Albion College, and was partially funded by NMFS HMS Management Division.

In June of 2000, 30 identifiable adults in 164 mating events were recorded, and 19% of the total (109) juveniles tagged were recaptured. Progress this year included recording two gravid females in October, a result of the June mating and two fresh nurse sharks egg cases on the

sea floor not far from these females, all in the identified mating/nursery grounds and study area. The passing of large open egg cases is a sign that parturition is a few weeks away. These observations, with the presence in June of neonates, confirm that the shallow study lagoon is indeed a pupping and nursery area as well as a mating ground.

In addition to surveys of neonates and larger juveniles, behavioral documentation, and environmental data are collected, as well. Environmental parameters including time of day, temperature, tide, moon phase, substrate type and associated biotic community are routinely monitored and recorded on videotape and data boards. Temperature information is down-loaded from a local NOAA data buoy over the Internet. An analysis to look at effects on this nursery ground from El Nino and the North Atlantic Oscillation showed no significant correlation with the mating activities data set thus far.

The life history stages, behaviors and potential habitat affiliations that have been revealed to date are intriguing and require more investigation. Understanding this essential fish habitat as breeding and nursery grounds will set a broad foundation from which to conduct life history, habitat and behavioral studies of other species of sharks.

3.1.2 Movement Patterns and Habitat Associations of Juvenile Sandbar Sharks in Delaware Bay

* The following is excerpted from Wetherbee, B. M., E. L. Rechisky and H. L. Pratt. 2000. *Movement Patterns of Juvenile Sandbar Sharks on Their Delaware Bay Nursery Grounds*. Apex Predators Program. US DOC, NOAA, NMFS, NEFSC, Narragansett Laboratory, Narragansett, RI.

Introduction

For optimal recovery of sandbar shark stocks, which have been subject to fishing pressure over the last several decades and have been depressed, the nursery grounds for this species must be maintained as suitable habitat, which is dependent upon understanding the utilization of the nurseries by the sharks. Thus, the necessity for research including delineation of shark nurseries, patterns of habitat use and environmental tolerances of sharks in nurseries, and the overall role of coastal/inshore habitats in supporting juvenile sharks has recently received much emphasis.

Acoustic telemetry studies yield information on fine-scale movements of individual animals, which is useful for inferring habitat preferences and activity patterns. Such data are crucial for thorough evaluation of the effects of fishing and habitat degradation on populations, and in turn for assessment of the potential success of management techniques such as area/time closures. Delaware Bay, one of the principal nursery grounds for sandbar sharks on the US East Coast, was chosen as the site for a telemetry study to investigate movement patterns and spatial and habitat requirements of these sharks. The study was funded by NMFS NEFSC, NMFS HMS Management Division and the National Research Council.

Summary of Findings

Ultrasonic telemetry was used to document the movement patterns and habitat use of juvenile sandbar sharks in Delaware Bay. A total of 25 sharks was tracked during June-September, 1998 and 1999; 19 tracks on the Delaware side of the bay and six on the New Jersey side. Findings show that young sandbar sharks are common near-shore on both sides of Delaware Bay, and are not abundant in the deeper, middle section of the bay, presumably as a means of avoiding predation by large sharks that occur in the central bay. Based on nearly 850 h of tracking data, movement patterns exhibited by juvenile sandbar sharks in this study were generally heavily influenced by tidal currents, restricted to a limited portion of the bay, and dependent upon the side of the bay where tracking was initiated.

Behavior patterns of young sandbar sharks in Delaware Bay appear to include repetitive movements on several scales, and are indicative of site fidelity for these sharks. Firstly, movements of sharks were strongly associated with tidal currents and were generally repeated several times a day with each tidal cycle. Secondly, repeatable behavior on a daily basis within individual sharks was demonstrated by the high degree of overlap between activity spaces of consecutive days for sharks in areas of high shark activity. Thirdly, repeatability of behavior among individual sharks was observed in the study as demonstrated by a high degree of overlap of activity spaces among different individuals.

Juvenile sandbar sharks restrict the majority of their movements to a relatively small portion of Delaware Bay. There are clearly areas in the bay where activity of sharks is concentrated, such as Broadkill and Bigstone beaches, DE. Multiple sharks spend considerable time in common areas, and catch data also suggests that large numbers of sharks inhabit these areas. The tracking studies were conducted over the course of the entire summer, indicating that there is a degree of site fidelity in sandbar sharks during the entire time they are residents in Delaware Bay.

There are a number of factors that may influence the behaviors observed. The more restricted movements in shallow, near-shore water on the Delaware side may be a reflection of the presence of a more extensive, shallow shelf on that side of the bay in comparison to the New Jersey side. Differences in substrate may also explain the behavioral patterns observed in sharks; the New Jersey side of the bay is characterized by large oyster beds, whereas the Delaware side is predominately fine sediment with very few oysters. Since the diet of young sandbar sharks is dominated by a few prey types, the movements of the sharks may also be related to prey distribution.

3.1.3 Other Shark Nursery Area Research

The University of Mississippi is completing a MARFIN research project (Grant Number

NA77FF0548) to identify and characterize shark nursery grounds in the northern Gulf of Mexico. The project collected sharks from coastal Mississippi and Alabama waters to describe the temporal and spatial components of shark nursery areas. Sharks were also tagged and released to examine growth and movement patterns in northern Gulf waters.

3.2 Atlantic Billfish

Joseph E. Serafy, Thomas R. Capo, Claire B. Paris and Robert K. Cowen are working cooperatively on early life history studies on Atlantic Billfishes off Lee Stocking Island in the Bahamas. The original goal of this research was to address some fundamental questions surrounding the biology and ecology of the Atlantic billfishes, with particular emphasis on the earliest life stages inhabiting the surface waters off Lee Stocking Island (LSI). It is important to note that this project changed in scope and emphasis by expanding the spatial extent of this study well beyond the pelagic waters adjacent to LSI, thereby gaining a comprehensive view of larval billfish density-distribution throughout Exuma Sound.

Each istiophorid larva collected was separated from other biota, examined under a dissecting microscope and tentatively placed into one of three taxonomic categories. Based on snout morphometry and pigment patterns the three taxonomic categories were: (1) blue marlin;(2) white marlin or sailfish; and (3) undetermined istiophorid. The latter category was composed primarily of partially larvae less than 5 mm in length. The Exuma Sound efforts yielded a total of 100 individual billfish larvae. Of these, 82 have been tentatively identified as blue marlin, two are identified as either white marlin or sailfish and the remainder (16) are as yet identified as "undetermined istiophorids". Researchers are currently in the process of removing the eye tissue of all 100 specimens for genetic determination of species identity. Also in progress are measurements of the total length of each specimen. In the case of confirmed blue marlin, these lengths can then be converted in to an estimated age using empirically-derived equations.. Knowledge of larval blue marlin age, coupled with details of the flow environment, is important for hindcasting the probable spawning locations and times. Further, measurements of size-at-age may provide proxy of condition of the young that may relate to habitat quality (e.g. fish from high food habitats experience high growth rates). Once individuals have been identified genetically, species-specific density-distribution maps can be generated and an estimate of probable spawning times and locations determined.

3.3 Swordfish

The South Carolina Department of Natural Resources, Marine Resources Research Institute is currently working on a research program designed to determine the importance of the Charleston Bump and associated oceanographic features (currents, circulation, sources, productivity) in the life history of large oceanic pelagic fishes, including swordfish, sailfish, tunas and marlins. A Charleston Bump Colloquium was held in Charleston, SC, with a total of 16 papers presented covering the geology, physical oceanography, and fisheries of this area. Studies of the Charleston Bump include hydrographic surveys and bottom mapping, logbook data

analyses, satellite pop-off tagging. During 2000, swordfish and sailfish were tagged and released from the Charleston Bump area using pop-off satellite tags. Three pop-off periods were used in this study, 30-day (10 swordfish), 60-day (10 swordfish), and 90-day (9 swordfish, 1 sailfish) tags. Two 5-day tags (1 swordfish, 1 sailfish) were also used as a system test. Of the 10 swordfish tagged with 30-day tags, information from 7 tags was recovered, with fish moving an average of 529 km, mainly moving to the east toward Bermuda. Information from six, 60-day tags was received, with swordfish moving an average of 1,120 km to the north and northeast from the release location. A total of 8 of the 9, 90-day tagged swordfish were recovered, with these fish moving an average of 1,104 km, with movement in generally a north to northeast direction near submarine canyons or along the Gulf Stream. Four of the swordfish did not move away from the Charleston Bump area, even after 90 days. The two sailfish moved 98 km in 5 days, while the sailfish tagged with a 90-day tag moved 1,581 km.

The temperature profiles provided from the satellite tags indicate active diel movement patterns, migrating from warm surface waters to cooler waters at depth. Swordfish appear to be attracted to complex, high-relief bottom structure and complex thermal structure consisting of fronts where warm Gulf Stream waters meet cooler shelf, slope and Labrador Current waters. The Charleston Bump appears to be an important habitat for swordfish, and also functions as a "stepping stone" along the path of seasonal migration of the swordfish.

3.4 Bluefin Tuna

Results of archival and pop-up tagging of bluefin in the western North Atlantic by the Stanford-NMFS group was reported by Block et al. (SCRS/00/148). A total of 380 Atlantic bluefin have been equipped with implantable archival tags or pop-up satellite tags since 1996. Of the 279 implantable archival tags deployed, 30 have been recovered and 21 of these instruments have been returned. Seventy pop-up satellite tags have provided positions, ambient temperature and/or depth movements. This represents 90% of the expected returns from deployed pop-up satellite tags. Data on seasonal movements, trans-Atlantic movement patterns, depth preferences and breeding behaviors have been obtained for fish assumed to be in the age 6-13 range. The authors suggest that bluefin tagged in the west display at least three distinct types of behaviors: (1) western residency with no visitation to spawning areas, (2) western residency with Gulf of Mexico breeding, and (3) trans-Atlantic migrations to the east Atlantic or Mediterranean Sea. Again the high success of the pop-up tags was noted compared to the eastern study. The Group recommended that there be additional releases in the Gulf of Mexico in order to better understand spawning site fidelity.

Section 3 References

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